EMISSION INVENTORY

CATEGORIES #288, #289

FUEL COMBUSTION - STATIONARY SOURCES
DOMESTIC SOLID FUEL - WOOD
Woodstoves (#288), Fireplaces (#289)

1999 EMISSIONS

Introduction

This methodology is used to estimate the criteria pollutant emissions from residential wood combustion, namely from fireplace and woodstove. Fireplaces are the most common wood burning device in a home.   They are used primarily for supplemental heating and for aesthetic appeal. Fireplace combustion is characterized by high air-to-fuel ratios and burn rates. Traditional masonry type typically has large open fireboxes without combustion air controls and are not highly efficient heating devices. A net heat loss may occur in a residence if colder, outside air is drawn in to replace the inside air used for combustion and lost through the chimney draft. There are also prefabricated (metal) fireplaces which are slightly higher in energy efficiency than masonry fireplaces. Fireplace inserts that fit into the fireplace can increase the heating efficiency by either radiating the heat into the house or venting heated air into the house by air circulating around the insert with the help of a fan.

Woodstoves are used primarily as domestic space heaters and have enclosed fireboxes and dampers to reduce air-to-fuel ratios and burn rates. Since they are stand alone heating devices, the greater surface area radiates more heat than a fireplace.

The emissions from residential fireplaces and woodstoves are highly variable, depending on the amount of wood burned and the types of woodstoves and fireplaces being used for burning wood. Many assumptions were made with the realization that any variations in one or more of these variables would substantially change the calculations.

Methodologies

The emission estimates from woodstoves and fireplaces followed CARB's methodology found in their Emission Inventory Procedural Manual, Volume III, Methods for Assessing Area Source Emissions (Sept. 1995).

Woodstoves

The number of woodstoves was estimated from the 1990 US Census which provided the number of residences in each District's nine counties burning wood for heating purposes. These figures were revised to 1999 values using household growth data from ABAG.

The annual throughput is calculated using the energy consumption equation (below) which estimates the average energy demand for each county:

$$E = C_D(16.86 \text{ X UA X DD})/(k \text{ X V})$$
$$\text{where UA} = q_L/(t_{outside} - t_{inside})$$

E = Annual energy consumption in cords.
C_D = 0.8 (correction factor for heating effect versus 65°F degree-day.
q_L = Designed heat loss (in BTU) for a house, including infiltration and ventilation.
UA= 463.28 BTU/hr (overall inside-to-outside thermal conductance for a residence).
DD= Number of degree days for a county (measured in 1991).
k = 0.6 (an averaged correction factor that includes the effects of rated full load efficiency, part load performance, oversizing and energy conservation devices.
V = Heating value of fuel in BTU/Cord (county specific).
16.86 is estimated hours per day wood is burned

This was done for each of the District's nine counties to get the total throughput, which in 1999 was 62,454 cords of wood burned/year (124,907 tons of wood burned per year).

The 1999 emission factors (lbs./ton) for woodstoves, which include the Phase I and II stoves, are as follows:

PM	28.4
TOG	31.0
NO_x	2.6
SO_x	0.4
CO	180.0

Multiplying the throughput (tons wood burned/yr.) with the respective emission factors give the criteria pollutant emissions from woodstoves.

Fireplaces

The throughput for fireplaces was derived from several surveys done for CARB in prior years. To estimate the number of houses in each county with "active" fireplaces, the percent wood burning household factor (determined from Northern California Research Associates', "The California Residential Wood Consumption Survey") is multiplied by the total number of houses in the county minus the number of homes that use wood for heating purposes for each county. This resultant value is then multiplied by the average amount of wood burned in a

fireplace, estimated to be 0.28 cord per year, to give the amount of wood burned per year in the particular county. Below is the equation estimating throughput of wood burned in fireplaces in the District:

$$\text{Throughput} = \left[\left(\begin{array}{c}\text{number of}\\\text{households}\\\text{in a county}\end{array} \times \begin{array}{c}\text{percent}\\\text{woodburning}\\\text{household factor}\end{array}\right) - \begin{array}{c}\text{number of homes}\\\text{using wood for}\\\text{heating purposes}\end{array}\right] \times 0.28 \text{ cord}$$

In 1999, the District's fireplace throughput was estimated to be 237,638 cords of wood burned (356,459 tons of wood burned).

The 1999 emission factors (lbs/ton) for fireplaces are as follows:

PM	34.6
TOG	31.0
NO_x	2.6
SO_x	0.4
CO	252.6

Multiplying the throughput (tons wood burned/yr.) with the respective emission factors give the criteria pollutant emissions from fireplaces.

Monthly Variation

The monthly variation for woodburning in woodstoves and fireplaces is based on data of domestic natural gas usage, by county and by month. This was provided by PG&E's Customer Accounting Department. For all counties except Solano and Sonoma, single data sets provided for the entire counties were used. For Solano and Sonoma Counties, (both only partially in the District), data summed for cities in the District were used, instead. For Solano County, data sets used were for Benicia, Fairfield, Suisun and Vallejo. For Sonoma County, data sets used were for Cotati, Petaluma, Rohnert Park, Santa Rosa, Sebastopol and Sonoma.

County Distribution

For woodstoves and fireplaces, the distribution of emissions was based on the amount of wood burned (throughput) in each county. (See the *Methodology* section for Woodstoves and Fireplaces for throughput calculations.)

TRENDS

Growth

Future projections of emissions are based on household growth in the Bay Area from projections report published by ABAG.

CONTROL

The District currently has no requirements applying to residential wood combustion except the EPA's Standards of Performance for New Stationary Sources (NSPS) for residential wood heater (stoves). (This is adopted by reference in the District Regulation 10.) The NSPS required that new residential heaters manufactured on or after July 1, 1988, or sold on or after July 1, 1990 be certified to meet particulate emission standards of 5.5 grams per hour for catalytic wood heaters and 8.8 grams per hour for non-catalytic wood heaters. These are known as Phase I stoves. More restrictive particulate emission standards were set for stoves manufactured on or after July 1, 1990 or sold after July 1, 1992. For catalytic wood heaters this was 4.1 grams per hour and for non-catalytic wood heater this was 7.5 grams per hour. These are known as Phase II stoves. Although EPA has only set emission limits for particulate matter, emission of reactive organic compounds and carbon monoxide are expected to be limited as well.

Natural gas fireplaces and natural gas woodstoves are increasing in popularity every year. Particulate emissions from these heating devices are insignificant. Some communities have (or are looking at) restricting new fireplaces to natural gas. In 1999 communities affected with restricting fireplace regulations include Los Gatos, Dublin, Palo Alto, and San Jose.